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Changes in European sulphur dioxide, nitrogen oxides and CO_2 emissions since 1960

Emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO_X) have fallen significantly across Europe since 1960. According to recent research, this is caused by a combination of factors including improved energy efficiency, a changing fuel mix and specific emission control measures. At the same time CO_2 emissions have only increased moderately, mainly due to improvements in energy efficiency.

Air pollutants and greenhouse gases (GHGs) together harm human heath, damage natural habitats and cause climate change. Understanding which factors influence their emissions levels is therefore vital for effective policy.

Emissions are affected by population changes, economic development, energy demand and the emission intensity of the energy consumption. The latter may be quantified as emissions of GHGs (in particular CO_2) or air pollutants, divided by the GDP of a country. The emission intensity is, in turn, affected by:

1) Economic and/or energy intensity changes (changes in energy consumption in relation to GDP). These are caused by structural changes in national economies (such as when a country reduces its energy-intensive manufacturing activities and increases its service industries which use less energy); improved efficiency in the energy system (such as replacing an old power station with a more efficient one); and behavioural changes.
2) Changes in the fuel mix of energy consumption.
3) The use of emission control measures aimed at reducing pollution through 'end-of-pipe' technologies. For example, technologies to clean emissions from smokestacks.

The researchers estimated emissions of SO_2, NO_X and CO_2 from 1960 to 2010, for nine types of fuel, five different sectors and 39 European countries. They used information from a number of sources, including national and international statistics, databases and models.

Countries were grouped into two regions: Western Europe, defined as the 15 EU Members before 2004 plus Switzerland and Norway; and Eastern Europe, which included the 12 post-2004 EU Member States, non-EU Balkan countries, Turkey, Belarus, Ukraine and Moldova.

The study traced the impact of the interacting factors that drive emission changes over time. In Western Europe, SO_2 emissions initially rose in line with economic development. However, from 1970 to 2010, they declined by 90%, mainly as a result of changes in the fuel mix (e.g. growth in the use of natural gas) together with improved energy efficiencies and the use of pollution control technologies. This is despite the fact that the overall energy consumption went up during this time.

In Eastern Europe, SO_2 emissions only started to fall after 1990 when recession led to a drop in energy consumption. Reductions there were also partly due to improved energy efficiency, swapping coal for natural gas and new pollution control policies.

Due to an increase in energy consumption, NO_X emissions in both Western and Eastern Europe peaked in the 1980s, but then declined; falling 50% compared to peak values by 2010, thanks to new emission control measures. However, growth in the transport sector since the 1990s, together with a shift towards diesel vehicles, which emit more NO_X than petrol vehicles, have reduced control measures' positive impact.

Economic changes in a country, improved energy efficiencies and energy-saving measures have played a major role in slowing down the growth of CO_2 emissions in Western Europe. For instance, by 2010, CO_2 emissions would have been 30% higher if it were not for the increased use of non-fossil fuels. However, the shift towards natural gas, renewables and nuclear energy has lagged behind in Eastern Europe.

Overall, this study reveals that a combination of changes in the energy intensity, fuel mix, technology, as well as specific emission control measures, has lowered emissions of SO_2, NO_X and CO_2 across Europe between 1960 and 2010.